Ecosystem services' values and improved revenue collection for regional protected areas

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Abstract

The management of conservation areas is a costly enterprise, especially vulnerable to budget cutting when austerity measures are being considered. Optimal spatial taxation dictates that tax-payers contribute proportionally to the benefits they receive. This paper provides a framework to derive spatially varied benefit estimates for ecosystem services produced in Natura 2000 protected areas of Lombardy (Italy). These may be used as a framework for spatially optimised taxation to improve the efficiency of public funding. In the process we used non-market valuation techniques, as well as benefit functions' transfer.

Highlights

- A framework for the economic valuation of ecosystem services from Natura 2000 sites georeferenced across a wider region
- Analysis relies on choice experiments, benefit functions' transfer and mapping
- Average WTP values per person range between €2.28/year (slope protection) and €24.75 (carbon)

- Increases in ecosystem services supply correlate with increases in WTP value estimates but with significant differences depending on the ES taken into consideration

Keywords
Natura 2000; protected areas; ecosystem services; choice experiment; benefit transfer; Lombardy.

1. Introduction and policy background

Protected areas are aimed to conserve ecosystem integrity, safeguard ecological assets and maintain ecosystem services (ES) (Eastwood *et al.*, 2016). However, their public management is a costly enterprise, vulnerable to budget cutting when austerity measures are being considered. In order to improve management efficiency, specific spatially-targeted policies can be developed, to avoid that lack of spatial differentiation in the targeting mechanisms leads to efficiency losses (Wünscher *et al*., 2008). Among spatially targeted policies, financing via spatially differentiated taxes represents one option (Pirard, 2012). The design of such policies, however, requires specific information on the locations of economic benefits generated by ES as provided by geographically specific protected areas. Optimal spatial taxation dictates that tax payers ought to contribute proportionally to the benefits they receive.

This study provides spatially varied benefit estimates for ES produced by Natura 2000 protected areas in the region of Lombardy (Italy). Estimates are developed through stated preferences methods (choice experiments) and may be used as both a framework for spatially optimised taxation and to improve the efficiency in collecting public funds.

The literature on spatial explicit willingness to pay (WTP) values in stated preferences research is quite vast and it addresses the topic from different angles. This includes, among others, literature on distance decay effect on benefits and the role of substitute sites (Smith, 1993; Bateman *et al*., 2006; Schaafsma *et al*., 2013), spatial patterns (Johnston and Duke, 2009; Johnston and Ramachandran, 2013; Johnston *et al*., 2015; Holland and Johnston, 2017) and solutions for inferring how WTP values vary on maps, for example by means of interpolation methods and simple prediction (Campbell *et al*., 2009; Czajkowski *et al*., 2016; Sagebiel *et al*., 2017). However the literature has paid limited attention to the challenges posed by spatial-specific assessment of ES (Zulian *et al*., 2018) to support policies and management practices in protected areas, including Natura 2000 sites.

The concept of ES is over one century old (Marsh, 1864), however only in the last thirty years (Gómez-Baggethun *et al*., 2010) has the scientific community forced the attention of policy makers to focus on the role that ES play in support of human activities. Interest in the issue has quickly grown from both public and private sectors (Ruckelshaus *et al*., 2015). With the publication of the Millennium Ecosystem Assessment (MEA, 2003) ES gained momentum within the international policy agenda as a way to improve the effectiveness of biodiversity-protection policies, thus encouraging research efforts (Fisher *et al*., 2009). While at the beginning MEA did not pay much attention to the economics of ES (TEEB, 2010), in recent years interest in the investigation of their economic value has grown. Such interest is mostly motivated by the need to develop economic incentives for self-sustaining conservation activities (Jack *et al*., 2008), through the creation of missing markets and the implementation of Payment for Ecosystem Services (PES) schemes to collect the necessary funds (Wunder, 2005).

ES have become a centrepiece of the European Union (EU) Biodiversity Strategy and their economic valuation can contribute to a better-informed decision-making (Maes *et al*., 2012; Schägner *et al*., 2013). In its resolution of 12th December 2013 on green infrastructure, the EU Parliament emphasised the need to strengthen capacity and knowledge in relation to the mapping and assessment of specific ecosystems and their services.

Natura 2000 (COM, 2011) is a EU-wide network of nature protection areas. Such network was designated under the 1979 EU Birds (79/409/EEC, replaced by 2009/147/EC) and the 1992 EU Habitats (92/43/EEC) Directives to ensure the conservation of valuable and threatened species/habitats. It consists of 27,308 terrestrial and marine Sites of Community Importance (SCI) and Special Protection Areas (SPAs) stretching over 100 million ha (i.e. roughly 18% of EU territory) (European Commission, 2017). Areas in the Natura 2000 network are a cornerstone of the goals to be reached by the EU Biodiversity Strategy by the year 2020. Yet, to date, the potential of the ES concept to add value to current conservation approaches remains insufficiently explored (Harrison *et al*., 2010; Ziv *et al*., 2017). In particular, more socio-economic research on the effects of Natura 2000 is needed (Popescu *et al*., 2014) given the current dearth of quantitative studies, especially of economic valuations of the benefits produced by the network (Gantioler *et al*., 2014). Existing studies are very context-specific and have either sub-national or local scale

(Bastian, 2013; Gibson *et al*., 2004; Chuan-Zhong *et al*., 2004; Hoyos *et al*., 2012). Some build on scaling-up of or extrapolating from available estimates (ten Brink *et al*., 2013). In different EU countries, Schulp *et al.* (2014) highlighted substantial gaps between ES assessment and mapping exercises, due to the lack of both a systematic method of primary data collection and consistency across methodological approaches. This paper reports a study intended to fill this gap focussing on the most industrialised region of Italy: Lombardy.

In Italy, information gaps are exacerbated by the fact that it is one of the most bio-diverse countries in Europe (UNEP-WCMC, 2004), where the SCI and SPA network covers about one-fifth of the land (European Commission, 2017). Anthropogenic pressure on natural resources and local ecosystems is high, while at the same time human wellbeing is strongly reliant on them (MELS, 2013). This paradox is particularly evident in Lombardy. It is the Italian region hosting the highest number of Natura 2000 sites (242) and the most populated national region (about 10 million inhabitants, 16.5% of the total country population) and the second in terms of population density (414 inhabitants/km^2) (Istat, 2015). It is also the region with the highest rates of land use given up to urbanization (Ispra, 2015), a process seriously encroaching on ES from natural ecosystems (Turbè *et al*., 2010). It hosts more than one-fourth of the Italian industrial activities classified as hazardous for environmental resources and human health (Ispra, 2013). Environmental regulations (2015 National Budget Law) stress the need to both understand the economics of ES as well as to develop a system to account for their values and market provision. Although Italy has been included within a number of studies regarding Natura 2000, the identification and valuation of ES within the network has just been introduced through a couple of recent EU Life+ projects (Gestire[1] and Making Good Natura[2]) and addressed by publications developed within them (e.g. Schirpke *et al*., 2014; Schirpke *et al*., 2017; Schirpke *et al*., 2018).

Economic valuation of ES is still the subject of a lively debate within the scientific community (Gómez-Baggethun and Ruiz Pérez, 2011). Influential researchers emphasise how knowledge gaps in this field may affect the capacity to inform policy (Ruckelshaus *et al*., 2015), thus potentially providing scope to improve the efficiency of natural resource

[1] www.naturachevale.it/en/
[2] www.lifemgn-serviziecosistemici.eu/EN/home/Pages/default.aspx

management and nature conservation (Pagiola *et al*., 2004; Heal *et al*., 2005; Silvis and van der Heide, 2013).

The present study aims to:

- develop a methodological approach for the economic assessment of the main ES provided by Natura 2000 network in Lombardy;
- test the approach with regards to a selection of non-marketed ES provided by two geographically separated protected areas within Lombardy;
- inform policy makers and set up guidelines for future periodical data collection and systematic accounting of ES values.

The study is novel since so far no economic assessment of ES provided by protected areas at the regional scale has been performed in Italy. Only few of them have been performed within EU (Christie and Rayment, 2012, Bateman *et al*., 2013). The study adopts a valuable and innovative 6-steps methodological approach (see paragraph 2) the outcomes of which can contribute to inform future policies in this sector, by providing valuable inputs for decision-makers.

2. A framework for Natura 2000 ES assessment in Lombardy

The study builds on the six methodological steps adopted for the aims of Action 5 of Gestire project and presented in detail in Pettenella *et al*. (2016), i.e.:

(1) **literature review** of economic assessments of ES and Natura 2000 sites in Lombardy;

(2) **identification of the three main potential ES** provided by each of the 242 Natura 2000 sites at regional scale. This included (i) an extensive analysis of the most recent (i.e. October 2014) official Standard Data Forms[3] for each site, as made available by the Ministry of Environment, Land and Sea, and (ii) identification and assessment of main potential ES per site based on a scoring system[4]. We revised assessments and scoring systems adopted in similar studies (Bastian, 2013; Schirpke *et al*., 2013) to link single habitat types to potential ES production. The most represented among ES categories—according to the Common International Classification of Ecosystem Services (CICES) version 4.3[5] (CICES, 2017)—are regulating (47%) and cultural ES (39%), while

[3] Standard Data Form have standardised structure and fields according to Commission Implementing Decision of 11 July 2011 concerning a site information format for Natura 2000 sites (notified under document C(2011) 4892)

[4] The following scores were used as a reference (Bastian, 2013; Schirpke *et al*., 2013): 0 null ES potentiality, 1 low ES potentiality, 2, average ES potentiality, and 3 high ES potentiality.

[5] While other ES classification systems -such as for example the one developed by the Millennium Ecosystem Assessment- consider four ES categories (i.e. provisioning, regulating, cultural and supporting

provisioning ES are less frequent (14%). The three most relevant single ES cover about fifty percent of total ES potential production: C1, aesthetic value (21%), R9, biodiversity (17%) and C2, tourism and recreation (11%);

(3) **economic assessment of selected ES with a functioning market**, as produced by the Natura 2000 network in Lombardy. These included: fodder, timber, non-timber forest products (NTFPs), water provision, and carbon sequestration. Estimates were obtained making references to market prices or by means of different market value-based approaches (transformation costs, substitution costs, etc.) depending on the ES;

(4) **discrete choice experiment** (henceforth DCE, McFadden, 1973; Louviere, 1991; Boxall *et al*., 1996) to estimate the marginal willingness-to-pay (WTP) for improving the quality of a selection of ES, treated as attributes in the DCE, and identified on the basis of step two. Two Natura 2000 sites were selected in Lombardy: Ticino and Adamello Regional Parks (see 2.1 below). They were chosen in order to cover both lowland (Ticino) and mountain (Adamello) areas within the region, which produce different sets of ES;

(5) Step five involved the estimation of **benefit function transfer (BFT)** to infer values of ES from study sites (for which we had sample observations) to policy sites (i.e. all municipalities within Lombardy without sample observations);

(6) The final step of the method involved **drawing conclusions and identifying future research needs**.

The core of the present study was in steps four and five, for which details are provided in Section 3 (Theory and Methods) below.

2.1 Study area

The 242 Natura 2000 sites in Lombardy cover two biogeographical regions (Figure 1): Alpine and Continental. Their combined area is about 372,000 ha, or about one-sixth of the region. These sites host 56 different habitats, 12 of which are considered of priority relevance according to EU Directives, as they are home to a variety of protected species: 82 bird species, 83 other animal species (i.e. mammals, fish, invertebrates and amphibians) and 27 plant species (Regione Lombardia, 2018).

ES) the CICES focuses on the first three ES categories. It does not explicitly include the supporting ES because they are treated as part of the underlying structures, processes and functions that characterise ecosystems. These ES are indirectly consumed or used and they may simultaneously facilitate the output of many ‘final outputs’, therefore they were thought to be best dealt within environmental accounts through other ways. For further information see: https://cices.eu/cices-structure/.

The DCEs survey focused on the ES generated by two regional parks within Lombardy (Figure 2): (i) **Adamello Regional Park** (henceforth Adamello RP) representing the Alpine biogeography and (ii) **Ticino Regional Park** (henceforth Ticino RP) representing the Continental biogeography. Adamello RP was created in 1983 and stretches over 51,000 ha in the Nort-East of Lombardy (Brescia province) at an altitude ranging from 390 to 3,591 mt above sea level (asl). The Adamello RP neighbours with two Italian parks and one Swiss: altogether they form the largest continuous protected area within the Alps.

The Adamello RP includes 14 SCIs, covering around 5,550 ha, and 1 SPA (4,974 ha). It also hosts part of the largest Italian glacier (Adamello glacier) and relevant prehistoric rock and cave paintings dating back to the Iron Age and included within a UNESCO World Heritage Site since1979.

The Ticino RP, created in 1974, is the oldest regional park in Italy. It includes the Lombard part of the Ticino River Valley and covers about 91,800 ha of lowland areas (56-427 m asl) along the Ticino River. The RP includes municipal areas of all 47 municipalities located along the river within the provinces of cities of Varese, Milan and Pavia. Ticino RP hosts 15 SCIs (10,971 ha) and 1 SPA (21,722 ha).

3. Material and methods

The ES under scrutiny, as produced by these protected areas, possess neither a proper market nor a related market for a weakly complementary good. Economic valuation must hence require non-market methods. To develop a value framework for the application of any non-market valuation method, it is necessary to hinge the practice on a theory of value consistent with individual utility theory. In our case the objective was to estimate the economic value to the Lombardy residents derived from changes in the flows of selected ES, as generated by the two Natura 2000 areas of Adamello and Ticino RPs.

Since utility is an ordinal concept, only utility changes can be associated with economic values by using the equivalence principle between utility states. Let ES_0 be the *status quo* flow of ES (e.g. Alpine meadows left unmanaged – low endemic flora) and ES_1 be the proposed change brought about by a policy action that modifies such ES flow (e.g. 200 ha of managed Alpine meadows – higher endemic flora). Then, the economic value to the individual Lombardy resident derived from the proposed policy change is defined by the compensating variation (CV) equivalence formula:

$$U(ES_0;Y)=U(ES_1;Y+\Delta Y)= U(ES_1;Y+CV) \qquad (1)$$

Where *U*(.) is the individual utility function, Y is income and ΔY defines the income change necessary to offset the variation in ES. The correct welfare measure change is ΔY=CV and its sign goes in the opposite direction of the perceived utility change without compensation: an improvement in ES flow from the status-quo generates a negative CV, as income level needs to be lowered to equalize utilities in the two endowment states (i.e. a payment is due) (Freeman III *et al.*, 2014).

Random utility modelling of discrete choice responses collected in choice experiments allows researchers to estimate the stochastic utility functions of the population from a sample of respondents. Because of the obvious variation of preferences for ES across residents, models with taste heterogeneity need to be fitted to the DCE data. We use a finite mixture (Scarpa *et al*., 2000; Boxall and Adamowicz, 2002; Scarpa and Thiene, 2005; Thiene *et al.,* 2015; Morey and Thiene, 2017) formulation of the mixed logit category of models (see also 3.1 below), also known as Latent Class model (LCM). With such estimates in hand, one can derive estimates of welfare change for specific policies affecting the various ES subject to evaluation, using the equivalence above. Because of the panel nature of the DCEs and the use of models with taste heterogeneity, such estimates can be computed at the individual level using Bayes's theorem and observed choice data (Train, 2003; Greene, Hensher and Rose, 2005; Scarpa *et al.,* 2008; Thiene *et al.*, 2013; Sarrias and Daziano 2018). Such estimates are then geo-referenced to the municipalities sampled in the survey and value maps of ES values are obtained. These are used to describe the spatial variation of economic values over the region.

Once the sample estimates for all marginal WTP changes are obtained they can be used, in conjunction with socio-economic covariates and geographical data, to estimate separate benefit functions for each marginal change and each ES. These functions describe how estimates of value vary across residential locations and individuals in Lombardy. For example, those residing far away from RPs might have lower values for ES improvements everything else equal. Alternatively, those living in urban areas might have higher values than those living in rural areas, because of the relative paucity of substitutes for ES in urban areas. Such benefit functions are used to infer values in areas not covered by our survey sampling by using the well-established technique of BFT (Loomis *et al.*, 1995; Downing and Ozuna, 1996; Kirchhoff *et al.*, 1997; Bergstrom and Civita, 1999; Smith *et al*., 2002; Vázquez-Polo *et al*., 2002; Moeltner *et al.*, 2007; Johnston and Moeltner, 2014; Moeltner and Rosenberger, 2014; Johnston *et al.*, 2015). This amounted to predicting average economic values for ES changes for residents of municipalities not represented in our DCE sample, the “policy” sites (1018 for Adamello RP and 1004 for Ticino RP), using the values from the sampled municipalities, the “study” sites (505 for Adamello RP and 519 for Ticino RP). Predictions were obtained by using benefit functions based on determinants selected on the basis of prediction performance criteria (see 3.2 below).

Maps with estimated or predicted values for ES can then be readily produced to illustrate to policy makers the distribution of values of each potential policy or combination of policies. These can be used to develop a revenue collection mechanism in which local taxes (regional rates) are spatially varied to match the spatial pattern of benefits as enjoyed by residents, delivering one of the principles of optimal tax theory and residential location theory. Incidentally, this could constitute a serious incentive for value revelation in public surveys as they would be perceived as highly consequential (Vossler *et al.*, 2012).

3.1 Choice experiments

After selecting a specific sub-set of ES for both Adamello RP and Ticino RP, two different online questionnaires were developed with their respective DCE surveys. Each of these were completed by about 1,500 respondents. Both samples were identified with the support of a company specialised in providing representative panels for on-line surveys: they included visitors and non-visitors, residing in Lombardy, aged 18-65, and were stratified according to selected socio-economic characteristics, as well as to the distance of their place of residence from the sites (5 zones). Each survey used a separate set of five policy dependent ES attributes and different policy-achievable levels were identified for each of them. The fifth was a proposed local annual tax increase, used as a payment vehicle, planned over a 5-year period and earmarked for expenditures necessary to deliver the quality improvement of the ES (Tables 1 and 2). Attributes and levels were discussed and agreed with the management staff of the two parks. Additional questions—based on a Likert-scale approach—were used to detect protest responses. This allowed those respondents who stated they were unwilling to pay additional taxes to elaborate on the reasons for such choice.

In order to reduce the risk of respondents ignoring one or more attributes included in the CE (attribute non-attendance), choice tasks were preceded by an introductory session aimed (among other things) at testing respondents’ familiarity with issues addressed by the survey. This session also provided basic information on the surveyed areas (including maps and pictures) and on topics covered by the choice experiment. Each respondent was presented with 12 choice tasks and in each they were asked to select their most preferred policy scenario between three alternatives (examples of choice tasks are reported in the Appendix together with an example of the online survey). Having a relatively high number of choice tasks per respondent allowed us to increase the number of observations for choice models estimation. Fatigue effects which may arise during the sequence are a possible drawback of our design, as such effects could increase the degree of randomness of choices and/or increase the probability of adoption of heuristic strategies (Caussade *et al*., 2005; Hensher, 2006). However, no relevant fatigue related issue emerged from the pre-test of the survey, so we leaned towards the certainty of having more data over the risk of a decrease in their accuracy. This choice was also corroborated by studies which found little to no evidence of fatigue effects (e.g. Carlsson *et al*., 2012; Czajkowski *et al*., 2014). The use of sequences longer than 10 choice tasks is also advisable to avoid bias in individual averages of marginal WTP estimates (Sarrias and Daziano 2018).

Opt-out options were not included as we wanted respondents to express a preference among possible ES improvement scenarios, given the relevance of such information for the authorities in charge of parks management. While this choice may have some drawback, the effects of the inclusion of the opt-out option are still debated (Veldwijk *et al*., 2014; Campbell and Erdem, 2018). A *status quo* alternative was not included to avoid any possible *status-quo* bias. A total number of 120 choice tasks were developed through an experimental design obtained with a dedicated software (Ngene by Choicemetrics, 2014). Results from preliminary pilot studies (about 30 per study-site) were used to design the surveys through a Bayesian efficient D-error minimizing design approach (Scarpa *et al*., 2007).

Data collected were used to estimate random utility models. Estimates were obtained for Multinomial Logit (MNL) and Latent Class Models (LCM), the latter models account for taste differences across respondents. We decided to explore taste heterogeneity by means of LCM rather than a Random Parameters Logit Model (RPL) because we found LCM to perform better on our data in preliminary analysis. Furthermore, LCM can be preferable to RPL when transferring results to policy makers (Sagebiel, 2017).

Choice models were used to derive individual marginal WTPs (WTP_m). MNL models were estimated through NLOGIT version 5.0 software, while LCM through Latent Gold Choice version 4.5. Based on individual WTPs, average WTPs per municipality were computed and mapped via ArcGIS for municipalities covered by the two surveys.

In choice experiments, the sequence of individuals' choices is modelled as a function of the attributes using Random Utility Theory (Luce, 1959; McFadden, 1973). According to the Random Utility Theory, for an individual *n* facing a set of *J* alternatives, denoted by *j*=1,…,*J*, the utility of choosing the alternative *i* is a function of the *K* characteristics of the alternative *i*. Utility functions are composed of a systematic part V_{ni} and a random part ε_i standing for all unobserved variables:

$$U_{ni} = V_{ni} + \varepsilon_i \qquad \forall\, i \; in \; J \tag{2}$$

The systematic part of the utility function of individual *n* associated with the selected alternative *i* is modelled as a linear function of the vector of the attributes x_i and associated parameters $\boldsymbol{\beta}_n$. If the unobserved error term ε_i is assumed to be i.i.d. extreme value type I, the probability of individual *n* choosing alternative *i* out of *J* alternatives can be defined by the MNL model:

$$\pi_{ni} = \frac{\exp(\boldsymbol{\beta}_n{}'\mathbf{x}_i)}{\sum_{j=1}^{J}\exp(\boldsymbol{\beta}_n{}'\mathbf{x}_j)} \tag{3}$$

A property of the MNL model is the Independence of Irrelevant Alternatives (IIA). The IIA property assumes that the choice probability of alternatives A and B is not influenced by the addition or exclusion of any additional alternative in the choice set. In general, this is a strong assumption that is often unrealistic. To relax this assumption, and to account for taste heterogeneity across respondents, we estimated a LCM (Boxall and Adamowicz, 2002, Scarpa et al. 2003). The LCM endogenously and probabilistically assigns sampled respondents to classes within which identical preferences are shared, but across which preference differ. However, as these classes are latent (i.e. unobservable by the analyst) a probabilistic equation explaining the probabilistic assignment of individual n into class *C* must be estimated. To specify the membership probability, we adopt a semi-parametric form based on a class-specific constant term α (Scarpa et al. 2003, Scarpa and Thiene, 2005), where for class 1 such term is set to zero for identification. Using a Logit formulation for the class allocation model, the probability that individual *n* belongs to segment *C* is given by (Bhat, 1997):

$$\pi_{nc} = \frac{\exp(\alpha_c)}{\sum_{c=2}^{c=C}\exp(\alpha_c)}\text{, where } \alpha_{c=1} = 0\text{, for identification purposes.} \tag{4}$$

Given membership to class c, choice probabilities follow the random utility framework. The probability that individual n chooses alternative i, conditional on belonging to taste group c, takes the logit form:

$$\pi_{ni|c} = \frac{\exp(\boldsymbol{\beta}'_{nc}\mathbf{x}_i)}{\sum_{j=1}^{j=J}\exp(\boldsymbol{\beta}'_{nc}\mathbf{x}_j)} \quad (5)$$

where $\mathbf{x}_j$ represents the vector of attribute levels associated with alternative j and $\boldsymbol{\beta}_{nc}$ is a conformable vector of coefficients for class c.

WTP values for each attribute $\mathbf{x}$ in each class c are computed as the opposite of the ratio between the attribute coefficient β_{xc} and the price coefficient β_{COSTc}:

$$WTP_{xc} = -\frac{\beta_{xc}}{\beta_{COSTc}} \quad (6)$$

3.2 Benefit transfer

Benefit transfer can be conducted with different methods. One of the most common is to estimate a benefit function (Loomis 1992; Rosenberger and Loomis, 2003; Leon-Gonzales and Scarpa, 2008), through which a conditional estimate of the expected benefit can be derived. The simplest form of BFT uses an estimated function from a single primary study to calculate a calibrated welfare estimate for the policy site. This is often denoted as single-site BFT (Rolfe and Bennett, 2006; Johnston and Rosenberger, 2010). The benefit function can be expressed as:

$$y_{pk} = (\mathbf{x}_{pk}, \boldsymbol{\beta}_p) \quad (7)$$

where y_{pk} is a predicted welfare estimate (in our case the WTP estimates from discrete choice models for a given ES change), $\mathbf{x}_{pk}$ is a vector of determinants upon which one can condition the welfare estimate from change in ES p for people at site k, and $\boldsymbol{\beta}_p$ is the associated vector of coefficients. In our study, the elements in $\mathbf{x}_{pk}$ were selected starting from some 60 different candidate determinants (see the Appendix for a full list) covering three main groups:

- *13 socio-demographic variables* profiling respondents. Data were collected during the survey. The individual variables actually used in the vector $\mathbf{x}_{pk}$ of the benefit transfer regression were age, sex, number of household members, occupation and average yearly income;
- *28 socio-demographic variables profiling the human dimension of municipalities* sourced from official statistics (i.e. from the National Institute for Statistics, Istat). The conditioning variables included in the vector $\mathbf{x}_{pk}$ of the benefit function were: total population, number of buildings, area covered by residential buildings, inhabitants' education and occupation, and population density;

- *14 territorial variables profiling the geographic dimension of municipalities* and obtained via elaboration of the geographical layers of the territorial database of the Lombardy region. Among those variables, we focused on those that were most likely to influence the perceived value of the ES, such as (for example) the presence of sites that can be considered as substitutes of the two parks object of the study. The layers analyzed were those relative to urban parks and green areas, regional parks, land cover (Corine 2000), and scenic itineraries. From those layers, two types of data were obtained: the (logarithmic) distance of each municipality from substitute sites (as from ArcGIS 'near' function) and the coverage of substitute sites within each single municipality (as from ArcGIS 'intersect' function). The distance from each municipality to Ticino and Adamello Regional Parks was also used as a variable in the BFT, as it is known to influence the perceived value of the ES (e.g. land cover, log distance from the two Parks, etc.).

The resulting dataset was used to estimate the BFT by means of multiple linear regressions, using the software R. Statistical performance was tested for every candidate BFT determinant and only those with predictive power were maintained in the final specification used for the value transfer. The final BFT function estimated on the municipalities for which we had estimates were then used to predict the BFT for those sites k, using the generic BFT:

$$\widehat{WTP}_{pk} = \sum_{m=1}^{M(p)} (\widehat{\alpha}_p + \widehat{\boldsymbol{\beta}}_{pm(p)}{}' \mathbf{x}_{km(p)}) \qquad (8)$$

where $\widehat{WTP}_{pk}$ is the predicted average WTP for the improvement of the ES p in municipality k, $\mathbf{x}_{km(p)}$ are the benefit determinants with values specific to the k municipality and $\widehat{\boldsymbol{\beta}}_{pm(p)}$ is the generic estimated coefficient determinant for attribute p as obtained from the regressions run on the municipalities for which we had data. The total number of determinants acting as predictor for each p^{th} ES varies, as indicated by $M(p)$.
In order to transfer the values to non-sampled areas, we included the values of the variables for each municipality and we multiplied them with the associated estimated coefficients. The coefficients estimated for the first block of variables (that is socio-demographic variables profiling respondents), were associated with the average values of the municipality. For example, the coefficient associated with respondents' age was

multiplied with the average age of the municipality inhabitants. The average WTP estimate for each non-sampled municipality was then computed by adding up each term in the function. Finally, we aggregated the values at municipality level, by multiplying the average WTP estimate with the number of inhabitants. Aggregate results were also mapped to visualize their distribution across the region.

4. Results

The main results from the research steps for the two DCEs with five BTF each are presented in the paragraphs below.

4.1 The choice experiments

Results for the two DCEs are reported separately for the two conservation areas. We deal with each in turn.

4.1.1 Preference for ES at Adamello Regional Park

The total number of respondents to the questionnaire was 1,502, 39.7% of whom had visited the park. 97.3% of them (i.e. 1,461) completed the survey, 53.5% of whom revealed to be in favour of paying a regional tax to fund the park (53.5%), while 43.8% opposed the tax but nonetheless stated to value the benefits from these conservation areas (i.e. score>2 on a Likert-scale). Only 2.7% of total respondents (i.e. 41 individuals) were classified as genuine protest respondents. The resulting choice models (MNL and LCM) were estimated on a panel of 17,532 choices (i.e. 1,461 respondents x 12 choice sets) with results reported in Table 5 showing that estimated marginal willingness-to-pay (WTP_m) grows as the scope of the conservation policy intensifies with significant differences across ES types. WTP_m values are higher for meadow flora conservation (up to €8.19/year for 300 ha of managed meadow areas) and slope protection (up to €4.43/year for 45 km of safe road network). Increasing the number of wild fauna sighting sites is less valued: it ranges between €0.91/year and €1.07/year for additional five and eight sites, respectively. Low WTP_m values were observed also in the case of new floristic trails: WTP_m for an additional trail is €1.09/year, while WTP_m for three and five additional trails is €0.76/year and €1.93/year, respectively.
The specification search for the LCM identified eight to be the best number of classes fitting the observed data according to the Bayesian and to the Corrected Akaike's information criteria, BIC and CAIC, respectively (Table 3). We obtained a total of 127

parameters estimates, few of which are statistically insignificant. The resulting LCM gives significant or near-significant cost coefficient estimates, all with the expected negative sign, except for class 7. Most of the ES effects are significant across classes, but for three of the eight classes (3, 7 and 8) the ES changes show mostly insignificant effects on utility (Table 6).

We observe preference differences across the eight classes, as one would expect. Class 1 (26.6%) tends to prefer the ES of slope stability but there are no clear differences with the other attributes. In addition to slope stability, Class two (21.3%) is sensitive to flora conservation within meadow habitats close to the forest margin, but does not display a high WTP for the maintenance/restoration of dry-stone walls to enhance landscape value. Class three (15.9%) shows only two negative and significant coefficients: flora conservation over a 300 ha area (CON_300) and the building of five additional floristic trails (FLOR_6). This group seems to be interested in conservation and recreation aspects dealing with vegetation within the Park. Class four (12.1%) displays insignificant effects for dry stone-walls and low levels of slope stability, while all other attributes are significant and imply high WTP_m values, especially for flora conservation within meadow habitats close to the forest margin and floristic trails. To these respondents ES from flowers and plants matter.

Class five (8.6%) also cares about plants conservation, although with lower WTP_m values. Class six (8.6%) displays high WTP_m for policy on flora conservation when large areas are involved (at least 300 ha) and shows the highest WTP_m for the restoration of dry-stone walls among all the eight classes. Class seven has a low membership probability (only 3.5%) and is characterised by a positive COST coefficient. Individuals in this class seem generally uninterested in improving the current provisioning of ES, as suggested by the many negative WTP values. Finally, the residual Class eight, has smallest membership probability (3.2%), with a primary interest in slope stability and flora conservation within meadow habitats close to forest margins. This class displays a very low marginal value of money and has very large WTP_m; it might be a class of wealthy respondents or a group of respondents twith strong preferences for these attributes.

4.1.2 Preference for ES at Ticino Regional Park

The survey for these ES was administered to 1,500 respondents, 50.8% of whom visited the park, with only 2.9% of observations (43 individuals) dropped for protest voting. 53.3% of respondents stated to be in favour of paying a regional tax to improve the park area.

The MNL model considered a total number of 17,484 observations (i.e. 1,457 respondents x 12 choice sets). As reported in Table 7, all but two coefficient estimates are insignificant, the rest show positive WTP_m, with the highest WTP_m estimates identified for carbon sequestration: respondents are willing to pay from €2.77/year for 5% emission reductions to €9.61/year for 20% reduction. Positive WTP_m are estimated also for Ticino river water quality (€0.58/year for 1 additional indicator species and €1.55/year for two species), water meadow conservation (€0.89/year for the conservation of additional 80 ha and €1.18/year for additional 130 ha), and scenic views with screened detractors (€0.87/year, €0.56/year and €1.43/year for additional 6, 8 and 12 screened detractors, respectively).

In the LCM, the specification search for the DCE data on ES produced by Ticino RP showed substantial heterogeneity, with information criteria preferring a 7-class model and 97 parameters estimates (Table 4). Most utility coefficient estimates are significant for all classes, except for classes two (21.4%) and four (about 13.8%). Class four is also the only class showing a positive COST coefficient (Table 8).

Class one (21.9%) includes people who appreciate all attributes except for (a) thematic trails that might have been considered to be already supplied at the appropriate level, and they are insignificantly different from zero; and (b) low improvements on water quality. The highest WTP_m estimate values are observed for CO_2 emission reduction (RCO_20) and landscape (BVED_12). Class two (21.4%) is focused only on high levels of CO_2 emission reduction.

A similar pattern of preferences are found in Class three (16.5%) that shows much higher WTP_m values for CO_2 emission reduction, which are significant at all levels, compared to Class two. Class four (13.8%) displays an unexpected positive value for the COST coefficient, which prevents us from computing meaningful WTP estimates. Class five (11.5%) shows an unusual pattern of alternating coefficient signs. Similarly to classes two and three, there is a clear preference for strong CO_2 reduction and some WTP for high levels of scenic views. Class six (11.4%) shows a very low marginal utility of money and consequently high levels of WTP_m values, possibly for the same reasons as classe eight in the sample for Adamello RP. What emerges in this class is a strong preference for CO_2 reduction, which increases as the effort to reduce it increases, as one would expect. It also shows substantive interest in other ES, but only when high policy effort is made. Finally, class seven is the one with smallest membership probability (3.5%).

4.1.3 Mapping

Individual-specific WTP_m values were computed using the panel LCM estimator, for all ES of the two DCE surveys. Mean and standard deviations of the distributions of the values are reported in appendix. These values were averaged across each municipality and used for a preliminary mapping. Maps have been developed for all ES and their policy levels. For the purpose of illustration we report here only some selected results: those for slope stability (Adamello RP) and carbon sequestration (Ticino RP) in Figures 3 and 4, respectively. Average WTPs for slope stability across all districts range between €2.28 for 35 km (STAB_35) and €7.64 for 45 km (STAB_45) of safe road network (baseline: 10 km). In general, municipalities with higher population densities tend to be associated with higher WTP values for the stability of slopes compared to low-density ones. While WTP values for the 45 km level are positive for most of the municipalities, the number of municipalities showing negative WTP values is much higher for the 35 km level, which tends to demonstrate that current provision is deemed highly insufficient.

Average WTP values for reduced CO_2 emissions range between €8.30 for 5% reduction and €24.75 for 20% reduction (baseline: 0%). The geographical distribution of averaged WTP_m values for a 5% reduction in CO_2 shows that these are positive for almost all municipalities, with many of them (mostly in Milan area and in the central part of the region) ranking over €7.50/person (all estimates are annual local tax payments for a period of five years). This is even more evident when considering a 20% reduction level, especially in the Central-Southern part of the region, but also in municipalities within and close-to the Ticino RP. Carbon sequestration seems to be perceived as a relevant ES by population throughout the region and for any attribute level.

4.2 Benefit transfer

The estimation of implied individual non-market benefits from the selected ES can be obtained only for a sub-set of the municipalities of Lombardy: those that were sampled (study municipalities). However, with adequate data and the determinants of such values, separate benefit function transfers for each ES were estimated and used to infer predicted values for all other “policy” municipalities. Of course, this process is tentative and has no intention to be policy-prescriptive, but only illustrative. This extended the “guesstimate” of average values across the entire 1,523 municipalities in Lombardy, multiplied by their respective population. As described in section 3.2, the first step to predict values in non-sampled municipality was the estimation of the benefit transfer function. As an example, in

Table 9 we report the results of the estimation of the linear regression for the ES floristic trails (level creation of 2 additional trails) in the Adamello RP. After testing the predicting power of all variables (see Appendix) we choose as our final model a specification, which includes only coefficients statistically significant at the 80% level ($p<0.2$). Literature suggests that this is an acceptable threshold for statistical significance in benefit transfer studies (Rosenberg and Loomis, 2000). Education (*edu*) has a positive effect on average WTP, whereas age (*age*) has a negative effect, suggesting that older and less educated individuals perceive less benefit from the improvement of this ES. Total population of the municipality (ln_pop_tot) has a positive effect on WTP. As highly urbanized cities usually offer scarce ES, it appears reasonable that residents of those areas would benefit from natural areas service improvement as they can easily visit them. The percentage of municipality soil covered by sparse vegetation (s_sparse) has a positive effect on average WTP, whereas the logarithm of the distance from the Adamello Park (l_dist) has a negative sign. This appears plausible, as individuals living far from the park are likely to perceive less benefit for the improvement of its ES, as suggested by the vast literature on distance decay (e.g. Schaafsma et al., 2013). Similar results, in terms of variables with significant effect and coefficient signs were obtained for the other two levels of the floristic trails attribute.

By using the coefficients estimated through the linear regression and the values of the related variables in each municipality, we then estimated the average WTP in each policy site. Finally, we aggregated the data at municipality level by multiplying the average WTP with the number of inhabitants. Table 10 summarizes the aggregate results for the ES provided by floristic trails in the Adamello RP. The benefits estimated for additional trails were mostly below €10,000/municipality: 79.1% in the case of 2 additional trails, 75.7% in the case of 4 and 48.1% in the case of 6. Nevertheless, for 6 additional trails, 21.1% of municipalities showed a total WTP higher than €30,000 (Table 7 and Figure 5). These figures can be used by managers of protected areas and policy makers to support their choices in terms, for example, of budget allocation and investments, including grants and subsidies. While trails are seen as an important asset at regional scale, as confirmed by the fact that in 2017 the Regional Council passed a new law recognizing the Regional Trail Network to value local natural and cultural resources, investment in trail maintenance activities within the whole regional Natura 2000 network between 2008 and 2011 only averaged about €156.000 (Gatto *et al*., 2015), which is a far lower amount than the total WTP that might be derived through the benefit transfer exercise.

5. Discussion, limitations and further research

The economic rationale behind investing in protected natural areas, including Natura 2000 sites, has given place to a participated debate in Europe (Hoyos *et al*., 2012). Since management costs for the EU-wise Natura 2000 network are expected to increase (Gantioler *et al*., 2014), motivating the financing of such investments represents a key political issue. Equitable and efficient taxation schemes must implement the beneficiary pays principle, and hence crucially depend on accurate estimates of the magnitudes of private benefits and their localization, as well as how their provision can be achieved by specific management policy actions implemented in a cost-effective manner.

With few exceptions, estimates from both MNL models and LCMs are consistent with the “more is better” principle: increases in ES supply correlate with increases in WTP value estimates. So, non-market values satisfy the theoretical validity criterion. Furthermore, LCMs accounts for how preferences vary across respondents. Such preference variation should be appropriately heeded by local policy-makers to spatially target the ES delivery as well as to equitably spread the associated tax burden.

The 6-steps methodological approach adopted for the study is not just instrumental to the research, but it represents one of its most valuable outputs. Yet, we are fully aware it would need substantive improvements to enhance evidence-based policy action, quality of research findings and, ultimately impacts. These would include:

- **FBT improvement:** it is recommendable to assess further WTP determinants by revising the list of socio-demographic and territorial variables used to develop the function(s) as well as to adopt spatial-econometric approaches, in order to take into consideration spatial correlation among data/WTP values. Although it is impossible to identify impacts of these measures *a priori*, it can be assumed they are likely to improve the quality of BT outputs. Testing spatial autocorrelation (e.g. by using specific functions available in many mapping tools) may also improve the FBT and further research in this area should be conducted;
- **Data enhancement:** stratifying the sample according to the distance from the two study sites (among other features) was a methodological prerequisite, but it was only partly achieved. This reflected on the quality of outcomes and should be carefully considered in future surveys. Although the two study sites are highly representative of mountainous and lowland areas in Lombardy, thus allowing a first approximation of the regional territory, they cannot cover the full range of situations

and nuances characterising the whole Natura 2000 network at the regional scale. It is then recommendable to perform additional surveys and studies at the scale of single sites or groups of sites in order to enrich data in both qualitative and quantitative terms. As an additional issue, some of the benefits from recreational ES are accrued to visitors from outside the region, i.e., the analysis presented within this paper, being focused on people resident in Lombardy, does not necessarily cover the entire population of beneficiaries for these ES;

- **Systematic data collection and management:** following on from the previous point, it would be worthwhile to develop a systematic data collection at the regional scale. This could consist of a dataset to be collected and reported according to standardised methodologies (units, frequency, periods, geo-reference, etc.) at the appropriate scale (e.g. single Natura 2000 site or cluster of sites) and with reference to one or more well-defined ES. Specific checklists could be developed and provided to site managers to fill them. Further data management could allow the identification of panels worth collecting in representative points so as to account for location-specific effects over time.

6. Conclusions

Conservation areas can be managed to produce different levels of flows of valuable ES in the form of local public goods, which are valued by residents in a manner that varies across the land and according to individual preferences. This poses a challenge to raising funds to finance such policies in an optimal manner. This paper makes a first empirical attempt at dealing with the issue of economic valuation of ES generated from two areas of conservation within the Natura 2000 network of Lombardy, Italy. Making local public good beneficiaries pay for ES requires a clear understanding of the relationship between policy actions and distribution of WTP over the land, and hence over different jurisdictions. Our proposed methodology can, in principle, deliver such information with the required degree of accuracy. A full mapping of partly measured and partly inferred estimates of marginal WTP were obtained for all municipal districts using a system of benefit function transfers. These estimates, once validated, could represent a base onto which elaborate an efficient local public revenue system for ES, reflective of both, patterns of human settlement and ES benefits.

Besides providing some preliminary economic values, the research contributes to the development of a methodology for assessing and monitoring ES over time by mapping and valuing them. Through further development and implementation of this methodology, regular monitoring and assessment of Natura 2000 benefits could be achieved and the database expanded in a cost-efficient manner. This would be in line with the requirements recently set by the environmental norms included within the 2015 (Italian) National Budget Law and - in more general terms - could provide an informative basis for developing future policies as well as supporting decision-making by other relevant actors (companies, citizens, private donors, etc.) in order to sustain the contribution of Natura 2000 areas to rural development and bio-based economy.

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Figures and tables

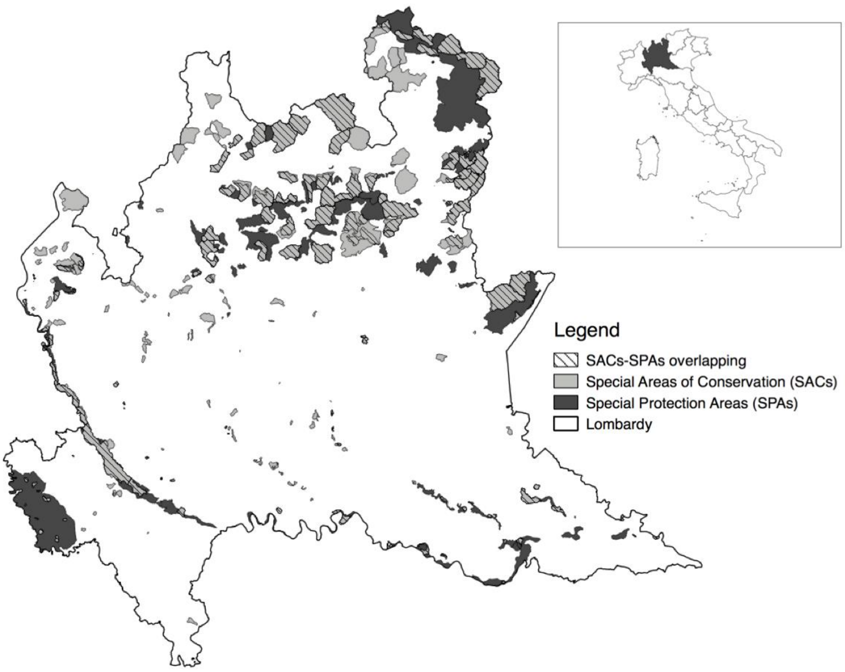

***Figure** 1: SACs and SPAs in Lombardy*

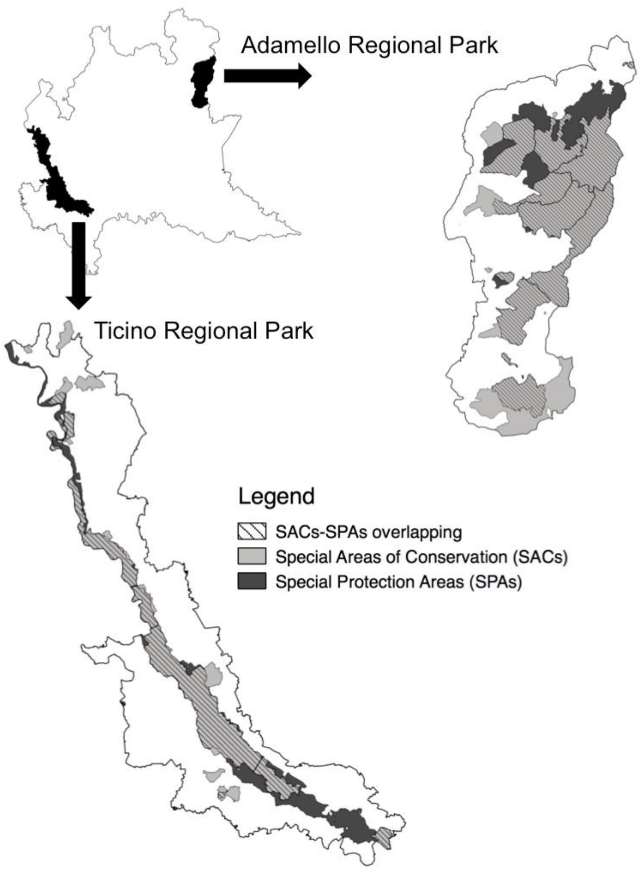

***Figure** 2: Study areas – Adamello and Ticino RPs*

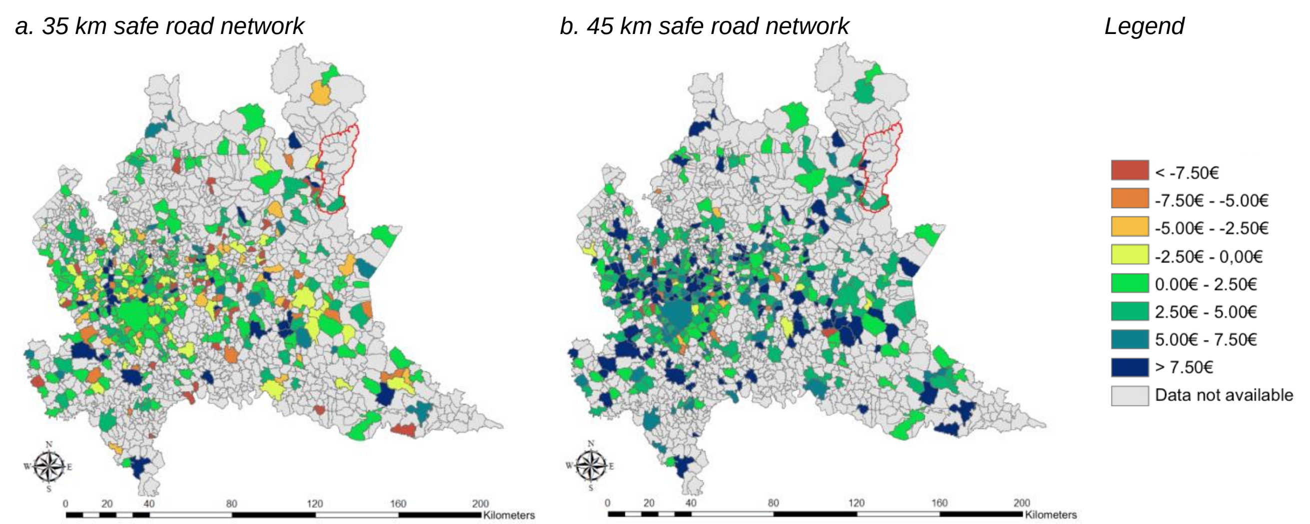

Figure 3*: Distribution of average WTP (€) within Lombardy municipalities covered by the survey for 2 different levels of the attribute "slope stability" in Adamello RP*

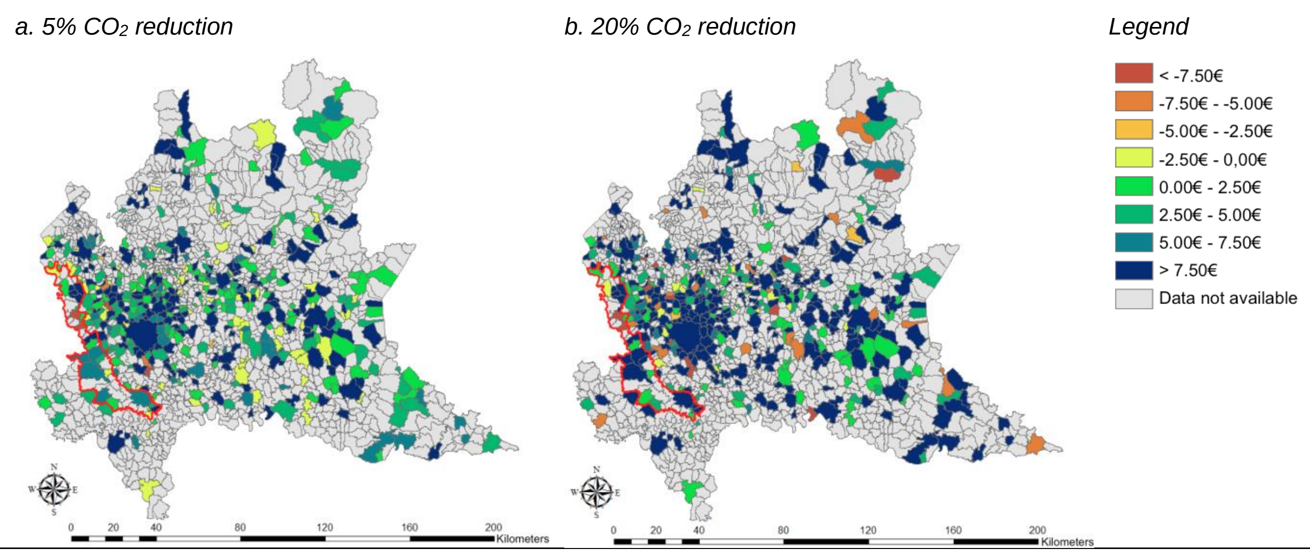

Figure 4*: Distribution of average WTP (€) within Lombardy municipalities covered by the survey for 2 different levels of the attribute "carbon sequestration" in Ticino RP*

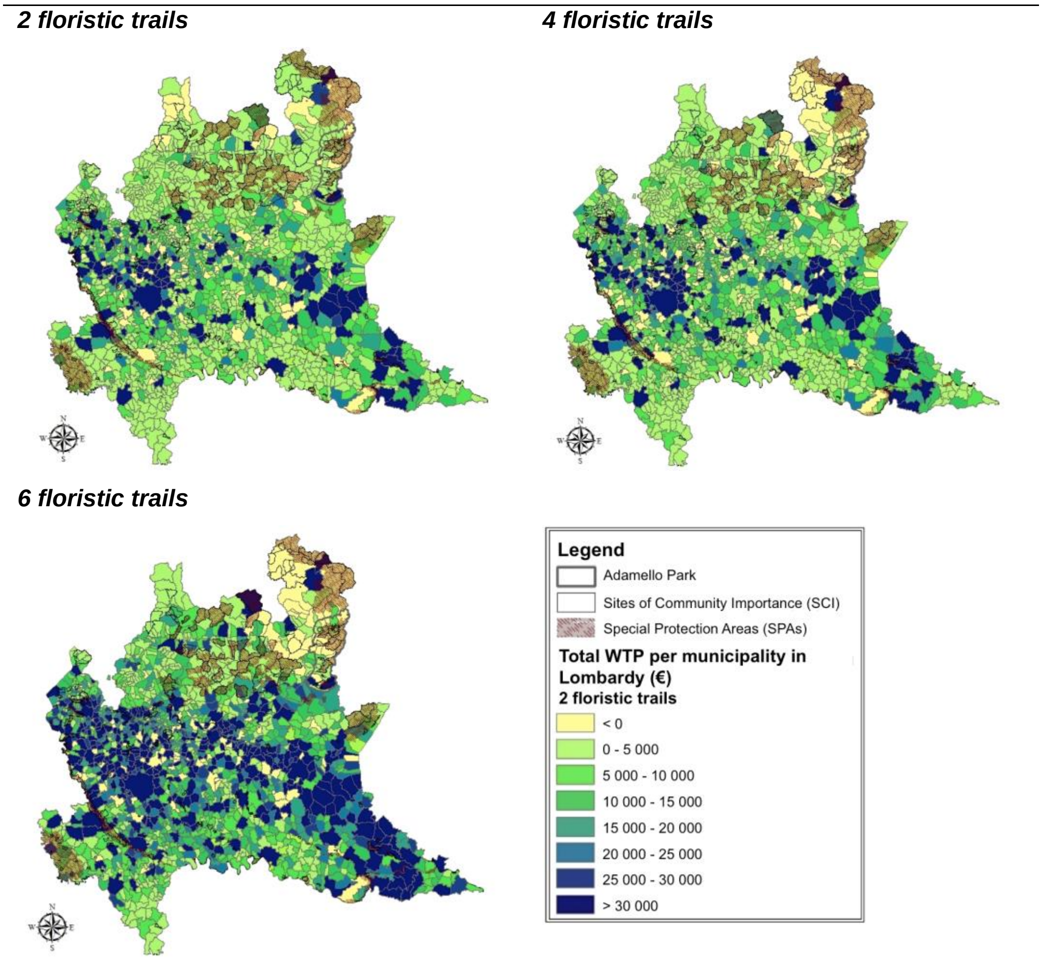

Figure 5: *Total WTP at municipal scale for different levels of the attribute "Floristic trails" in the Adamello RP*

Attributes	Abbreviations	Levels
Slope Stability Increased slope stability and consequent road safety	*STAB_10*	10 km safe road network (1/6 on 60 km) (baseline)
	STAB_20	20 km safe road network (1/3 on 60 km)
	STAB_35	35 km safe road network (7/12 on 60 km)
	STAB_45	45 km safe roads (9/12 on 60 km)
Flora Conservation Management practices to conserve flora in particular at the forest/meadow interface	*CON_0*	0 ha meadows managed (baseline)
	CON_200	200 ha meadows managed (1/16 of total meadow area)
	CON_250	250 ha meadows managed (1/13 of total meadow area)
	CON_300	300 ha meadows managed (1/11 of total meadow area)
Fauna Presence of fauna sighting sites	*FAUN_2*	2 fauna sighting sites (baseline)
	FAUN_5	5 fauna sighting sites (+3 sites)
	FAUN_7	7 fauna sighting sites (+5 sites)
	FAUN_10	10 fauna sighting sites (+8 sites)
Recreation Development of new trails to valorize floristic features in the area	*FLOR_1*	1 floristic trail (baseline)
	FLOR_2	2 floristic trails (+1 trail)
	FLOR_4	4 floristic trails (+3 trails)
	FLOR_6	6 floristic trails (+5 trails)
Landscape Maintenance of dry-stone wall as an indicator of landscape quality	*SEC_450*	450 ha dry-stone wall in good state (baseline)
	SEC_453	453 ha dry-stone wall in good state (+3 ha)
	SEC_455	455 ha ha dry-stone wall in good state (+5 ha)
Tax	*COST*	Regional tax (0€, 2€,5€,10€,15€,20€)

Table 1: *Adamello RP: Attributes, their abbreviations and levels*

Attributes	Abbreviations	Levels
Carbon sequestration Improved carbon sequestration through appropriate management practices	RCO_0	0% CO_2 emission reduction (baseline)
	RCO_5	5% CO_2 emission reduction (-0,42 tCO_2/year/inhabitant)
	RCO_10	10% CO_2 emission reduction (-0,84 tCO_2/ year/inhabitant
	RCO_20	20% CO_2 emission reduction (-1,67 tCO2/ year/inhabitant)
Water quality Number of fish species that indicate actual improvement of Ticino river water quality	WATQ_2	Ticino River water quality (2 indicator species) (baseline)
	WATQ_3	Ticino River water quality (3 indicator species) (+1 species)
	WATQ_4	Ticino River water quality (4 indicator species) (+2 species)
Biodiversity Conservation of valuable floral features, in particular water meadows	MAR_320	320 ha water meadow (baseline)
	MAR_400	400 ha water meadow (+80ha managed meadows)
	MAR_450	450 ha water meadow (+130ha managed meadows)
Landscape Number of scenic views with screened detractors as an indicator of landscape quality	BVED_0	0 scenic views with screened detractors (0 on 25) (baseline)
	BVED_6	6 scenic views with screened detractors (1/4 of total detractors)
	BVED_8	8 scenic views with screened detractors (1/3 of total detractors)
	BVED_12	12 scenic views with screened detractors (1/2 of total detractors)
Recreation Development of new thematic trails to offer additional recreational opportunities in the area	ITIN_62	62 thematic trails (baseline)
	ITIN_65	65 thematic trails (+3 trails)
	ITIN_67	67 thematic trails (+5 trails)
Tax	*COST*	Regional tax (0€, 2€,5€,10€,15€,20€)

Table 2: *Ticino RP: Attributes, their abbreviations and levels*

Number of classes	k	LL	BIC(LL)	AIC(LL)	AIC3(LL)	CAIC(LL)
1	15	-15017.3	30143.82	30064.51	30079.51	30158.82
2	31	-12917.5	26060.84	25896.94	25927.94	26091.84
3	47	-12448.5	25239.48	24991	25038	25286.48
4	63	-12261.4	24981.95	24648.88	24711.88	25044.95
5	79	-12097.8	24771.26	24353.6	24432.6	24850.26
6	95	-11999.2	24690.61	24188.36	24283.36	24785.61
7	111	-11915.1	24639.01	24052.16	24163.16	24750.01
8	127	-11847.1	24619.59	23948.16	24075.16	24746.59
9	143	-11794.4	24630.77	23874.75	24017.75	24773.77

Table 3: *Adamello RP: Information criteria*

Number of classes	k	LL	BIC(LL)	AIC(LL)	AIC3(LL)	CAIC(LL)
1	13	-15253	30600.78	30532.09	30545.09	30613.78
2	27	-13326.6	26849.96	26707.29	26734.29	26876.96
3	41	-12719.3	25737.15	25520.5	25561.5	25778.15
4	55	-12277.7	24956.09	24665.46	24720.46	25011.09
5	69	-12076.7	24656.08	24291.47	24360.47	24725.08
6	83	-11910.8	24426.27	23987.69	24070.69	24509.27
7	97	-11839.6	24385.85	23873.29	23970.29	24482.85
8	111	-11783.5	24375.56	23789.03	23900.03	24486.56

Table 4: *Ticino RP: Information criteria*

Choice (see Table 1)	**Coefficient**	**Std. Err.**	**z**	**95% Confidence Interval**		**WTP_m**	**Significance**
COST	-0.108	0.002	-71.31	-0.111	-0.105		***
STAB_20	0.125	0.027	4.67	0.072	0.177	1.156	***
STAB_35	0.305	0.027	11.32	0.252	0.358	2.828	***
STAB_45	0.478	0.026	18.54	0.428	0.529	4.433	***
CON_200	0.621	0.028	22.21	0.566	0.676	5.751	***
CON_250	0.693	0.029	24.30	0.637	0.748	6.417	***
CON_300	0.884	0.027	33.31	0.832	0.936	8.193	***
FAUN_5	0.015	0.028	0.54	-0.039	0.069	0.137	
FAUN_7	0.098	0.027	3.66	0.046	0.151	0.912	***
FAUN_10	0.116	0.026	4.48	0.065	0.166	1.071	***
FLOR_2	0.118	0.027	4.33	0.065	0.171	1.093	***
FLOR_4	0.082	0.027	3.00	0.028	0.135	0.758	***
FLOR_6	0.201	0.026	8.12	0.158	0.258	1.925	***
SEC_453	0.001	0.022	0.04	-0.042	0.044	0.009	
SEC_455	0.001	0.022	0.43	-0.033	0.052	0.087	

Note: ***,**,* = 99%, 95%, 90% significance

Table 5: *Adamello RP: MNL estimates*

Choice (see Table 1)	Class 1			Class 2			Class 3			Class 4			Class 5			Class 6			Class 7			Class 8		
	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m
COST	**-1.20**	-9.45		**-0.22**	-15.91		**-0.01**	-1.80		-0.05	-5.97		**-0.37**	-6.35		**-0.09**	-8.11		**0.14**	7.04		**-0.03**	-1.91	
STAB_20	-0.18	-0.82	-0.15	-0.02	-0.22	-0.09	0.10	1.51	9.09	0.11	1.02	2.20	**0.78**	2.28	2.11	-0.17	-1.39	-1.89	0.15	0.77	-1.07	**2.25**	2.91	75.00
STAB_35	**0.57**	3.07	0.48	0.13	1.28	0.59	**-0.14**	-1.78	-12.73	**0.30**	2.52	6.00	**1.45**	2.67	3.92	**-0.57**	-3.18	-6.33	0.06	0.28	-0.43	**3.28**	4.86	109.33
STAB_45	**0.96**	5.29	0.80	**0.65**	6.76	2.95	0.08	0.95	7.27	**0.88**	6.47	17.60	**1.48**	4.05	4.00	**0.47**	2.64	5.22	**0.76**	4.02	-5.43	**4.66**	5.98	-55.33
CON_200	**0.69**	2.88	0.58	**0.33**	3.17	1.50	-0.01	-0.19	-0.91	**2.33**	8.44	46.60	**5.56**	4.10	15.03	-0.27	-1.25	-3.00	**0.37**	1.66	-2.64	**1.39**	4.85	46.33
CON_250	**0.72**	4.02	0.60	**0.46**	4.17	2.09	0.06	0.86	5.45	**2.87**	10.20	57.40	**6.01**	4.15	16.24	**-0.53**	-2.91	-5.89	**0.44**	2.19	-3.14	**1.10**	3.15	36.67
CON_300	**0.69**	4.16	0.58	**0.82**	7.75	3.73	**0.20**	2.50	18.18	**3.83**	12.56	76.60	**6.86**	4.62	18.54	**1.19**	8.37	13.22	**0.88**	4.49	-6.29	**1.88**	6.28	62.67
FAUN_5	-0.13	-0.68	-0.11	0.16	1.63	0.73	0.03	0.42	2.73	**0.39**	3.18	7.80	0.34	0.95	0.92	**-0.42**	-3.06	-4.67	0.10	0.56	-0.71	0.30	1.11	10.00
FAUN_7	**0.48**	2.49	0.40	**0.44**	4.63	2.00	0.11	1.41	10.00	**0.28**	2.17	5.60	0.09	0.32	0.24	-0.21	-1.33	-2.33	-0.06	-0.36	0.43	0.29	1.06	9.67
FAUN_10	**0.40**	2.09	0.33	**0.41**	4.42	1.86	0.06	0.75	5.45	**0.58**	4.59	11.60	0.47	1.60	1.27	**0.34**	1.95	3.78	0.11	0.55	-0.79	0.27	1.08	9.00
FLOR_2	0.06	0.23	0.05	0.10	1.18	0.45	0.11	1.50	10.00	**0.39**	3.72	7.80	0.28	1.12	0.76	-0.19	-1.39	-2.11	-0.11	-0.60	0.79	-0.41	-1.35	-13.67
FLOR_4	0.02	0.10	0.02	**0.37**	4.14	1.68	**0.13**	1.85	11.82	**0.50**	4.60	10.00	0.28	1.28	0.76	**-0.66**	-4.50	-7.33	0.05	0.24	-0.36	-0.36	-0.75	-12.00
FLOR_6	**0.61**	3.18	0.51	**0.47**	5.49	2.14	**0.32**	4.13	29.09	**0.87**	8.06	17.40	0.41	1.54	1.11	-0.19	-1.22	-2.11	**0.42**	2.17	-3.00	-0.22	-0.43	-7.33
SEC_453	-0.04	-0.26	-0.03	**-0.27**	-3.67	-1.23	**-0.10**	-1.75	9.09	-0.08	-0.84	-1.60	0.10	0.45	0.27	**0.30**	2.02	3.33	0.00	-0.01	0.00	0.07	0.24	2.33
SEC_455	-0.03	-0.16	-0.03	-0.06	-0.74	-0.27	0.04	0.72	3.64	-0.07	-0.80	-1.40	0.32	1.53	0.86	**0.58**	4.14	6.44	-0.01	-0.06	0.07	-0.10	-0.44	-3.33
Log-likelihood	-11,847.08																							
Size	26.64			21.33			15.97			12.07			8.60			8.59			3.54			3.26		

***Table 6**: Adamello RP: LCM estimates (coefficients statistically significant at 90% level in bold)*

Choice (see Table 2)	Coefficient	Std. Err.	z	95% Confidence Interval		WTP_m	Significance
COST	-0.109	0.002	-66.91	-0.112	-0.106		***
RCO_5	0.302	0.028	10.76	0.247	0.357	2.773	***
RCO_10	0.592	0.028	20.87	0.537	0.648	5.434	***
RCO_20	1.047	0.029	36.00	0.990	1.104	9.606	***
WATQ_3	0.063	0.021	2.95	0.021	0.106	0.582	***
WATQ_4	0.169	0.022	7.80	0.127	0.212	1.552	***
MAR_400	0.097	0.022	4.37	0.054	0.141	0.890	***
MAR_450	0.128	0.022	5.97	0.086	0.171	1.178	***
BVED_6	0.095	0.026	3.68	0.044	0.145	0.868	***
BVED_8	0.062	0.03	2.06	0.003	0.120	0.564	***
BVED_12	0.156	0.027	5.83	0.104	0.209	1.434	***
ITIN_65	-0.228	0.022	-1.04	-0.066	0.020	-0.209	
ITIN_67	-0.034	0.021	-1.61	-0.076	0.007	-0.316	

Note: ***,**,* = 99%, 95%, 90% significance

***Table 7**: Ticino RP: MNL model estimates*

Choice (see Table 2)	Class 1			Class 2			Class 3			Class 4			Class 5			Class 6			Class 7		
	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m	Coeff.	z	WTP_m
COST	**-0.20**	-18.88		**-1.68**	-9.32		**-0.23**	-15.81		**0.02**	3.47		**-0.10**	-9.88		**-0.02**	-2.90		**-1.84**	-3.76	
RCO_5	**0.25**	2.88	1.25	**-0.56**	-2.15	-0.33	**2.53**	11.86	11.00	-0.06	-0.81	3.00	**0.27**	2.25	2.70	**1.49**	5.52	74.50	**22.66**	3.31	12.32
RCO_10	**0.33**	3.47	1.65	0.13	0.48	0.08	**3.00**	13.36	13.04	0.00	-0.01	0.00	-0.23	-1.54	-2.30	**3.28**	12.26	164.00	**9.35**	2.73	5.08
RCO_20	**0.58**	4.88	2.90	**1.76**	4.57	1.05	**4.54**	15.74	19.74	0.08	0.96	-4.00	**2.07**	10.14	20.70	**5.07**	16.52	253.50	**53.59**	3.58	29.13
WATQ_3	0.03	0.40	0.15	0.28	1.21	0.17	**0.17**	1.87	0.74	0.09	1.53	-4.50	**-0.64**	-5.80	-6.40	**0.20**	1.69	10.00	**-6.14**	-3.76	-3.34
WATQ_4	**0.20**	2.96	1.00	**0.43**	1.79	0.26	**0.49**	5.46	2.13	**0.29**	4.71	-14.50	**-0.56**	-5.15	-5.60	**0.33**	2.79	16.50	**-2.51**	-2.59	-1.36
MAR_400	**0.20**	3.01	1.00	0.28	1.14	0.17	0.05	0.58	0.22	-0.08	-1.43	4.00	-0.12	-1.35	-1.20	0.13	1.14	6.50	**-6.14**	-3.11	-3.34
MAR_450	**0.16**	2.57	0.80	0.17	0.89	0.10	0.01	0.11	0.04	-0.01	-0.12	0.50	**0.27**	2.99	2.70	0.43	3.88	21.50	-0.16	-0.20	-0.09
BVED_6	**0.41**	5.01	2.05	-0.34	-1.50	-0.20	-0.06	-0.58	-0.26	**0.13**	1.77	-6.50	-0.05	-0.37	-0.50	0.47	3.51	23.50	1.47	1.48	0.80
BVED_8	**0.28**	2.91	1.40	**-0.96**	-2.54	-0.57	**-0.45**	-3.39	-1.96	**0.26**	3.21	-13.00	**-0.85**	-4.68	-8.50	0.18	1.36	9.00	**-7.56**	-4.08	-4.11
BVED_12	**0.57**	5.80	2.85	**0.52**	1.73	0.31	0.03	0.24	0.13	**0.27**	3.58	-13.50	**1.22**	8.82	12.20	**0.33**	2.30	16.50	**25.42**	3.48	13.82
ITIN_65	-0.06	-0.86	-0.30	-0.15	-0.66	-0.09	**-0.23**	-2.44	-1.00	-0.05	-0.83	2.50	**-0.47**	-5.09	-4.70	**-0.25**	-2.13	-12.50	**-2.78**	-2.67	-1.51
ITIN_67	0.08	1.23	0.40	0.03	0.17	0.02	-0.06	-0.71	-0.26	-0.01	-0.23	0.50	-0.03	-0.36	-0.30	-0.19	-1.22	-3.50	**0.42**	2.17	2.14
Log-likelihood	-11,839.64																				
Size	21.96			21.41			16.49			13.77			11.43			11.42			3.52		

***Table 8**: Ticino RP: LCM estimates (coefficients statistically significant at 90% level in bold)*

Variable	Estimate	|t|	Pr(>|t|)
Intercept	6.79	2.64	0.008281
edu	0.7	1.53	0.127536
age	-0.1	3.42	0.000644
ln(pop_tot)	0.01	1.53	0.12615
s_sparse	3.44	1.57	0.117078
ln_dist	-0.83	1.75	0.079082
edu x ln(pop_tot)	0.02	-2.01	0.04547

Adjusted R-squared: 0.2232

Multiple R-squared: 0.2304

F-statistic: 18.24 on 7 and 1460 DF

p-value: <0.001

***Table 9**: Ticino RP: estimates of the BTF for 2 new floristic trails*

	2 floristic trails		4 floristic trails		6 floristic trails	
Total WTP (€)	no. municipalities	% on total	no. municipalities	% on total	no. municipalities	% on total
Less than 0	81	5.2	110	7.1	89	5.8
0 – 5,000	863	55.9	748	48.4	383	24.8
5,001 – 10,000	277	17.9	311	20.1	271	17.6
10,001 – 15,000	118	7.6	138	8.9	177	11.5
15,001 – 20,000	50	3.2	68	4.4	137	8.9
20,001 – 25,000	24	1.6	27	1.7	89	5.8
25,001 – 30,000	12	0.8	17	1.1	73	4.7
More than 30,000	119	7.7	125	8.1	325	21.0
Total	**1,544**	**100.0**	**1,544**	**100.0**	**1,544**	**100.0**

***Table 10**: Distribution of Lombardy municipalities within different total WTP classes for different levels of the attribute "Floristic trails" in the Adamello RP (absolute and % values)*

Appendix

List of variables used for the multiple regression

Acronym	**Description**	**Unit**
Age	Age	Years
Male	Male	*Dummy*
Female	Female	*Dummy*
Edu	Education level	Ordinal
Members	Number of household members	Units
l_self	Job-status: self-employed	*Dummy*
l_empl	Job-status: employed	*Dummy*
L_frla	Job-status: free lance	*Dummy*
L_entrep	Job-status: entrepreneur	*Dummy*
l_stud	Job-status: student	*Dummy*
l_hw_re	Job-status: housewife or househusband/retired	*Dummy*
l_une	Job-status: unemployed	*Dummy*
Income	Annual income	€
Tot_pop	Total resident population	Units
av_fam	Average number of household members	Units
Num_hous	Number of residential houses within the municipality	Units
Area	Surface area of resident population's houses	km^2
t_illit	Education level of resident population (> 6 years): illiterate	Percent over total municipal population above 6 years old
t_il_nq	Education level of resident population (> 6 years): illiterate, no educational qualification	Percent over total municipal population above 6 years old
t_prim	Education level of resident population (> 6 years): primary school	Percent over total municipal population above 6 years old
t_seco	Education level of resident population (> 6 years): secondary school	Percent over total municipal population above 6 years old
t_high	Education level of resident population (> 6 years): high-school	Percent over total municipal population above 6 years old
t_terz	Education level of resident population (> 6 years): tertiary education degree	Percent over total municipal population above 6 years old
t_univ	Education level of resident population (> 6 years): university degree	Percent over total municipal population above 6 years old
u_sec_19	High school diploma index by gender and age classes: males, over 19 years old	Percent over total municipal population above 19 years old
d_sec_19	High school diploma index by gender and age classes: females, over 19 years old	Percent over total municipal population above 19 years old
no_p_m	Early leavers index, 1st school cycle, per gender: males	Percent over total municipal population
no_p_f	Early leavers index, 1st school cycle, per gender: females	Percent over total municipal population
oc_agri	Employees by economic activity sector: agriculture	Percent over total employed population
oc_ind	Employees by economic activity sector: industry	Percent over total employed population
oc_com	Employees by economic activity sector: trade	Percent over total employed population
oc_fin	Employees by economic activity sector: finance	Percent over total employed population
oc_oth	Employees by economic activity sector: other activities	Percent over total employed population
cp_occ	Occupational status of resident population: employed	Percent over total municipal population
cp_look	Occupational status of resident population: looking for a job	Percent over total municipal population
cp_ret	Occupational status of resident population: retired	Percent over total municipal population
cp_stud	Occupational status of resident population: student	Percent over total municipal population
cp_house	Occupational status of resident population: housewife or househusband	Percent over total municipal population
cp_other	Occupational status of resident population: other	Percent over total municipal population
av_inc	Average income per municipality	€
Density	Population density	inhabitants/km^2
d_road	Road distance municipality-Park	km
l_d_road	Logarithm of road-distance municipality-Park	Linear m
l_d_reg	Logarithm of distance from the closest Regional Park	Linear m

Acronym	Description	Unit
l_d_urb	Logarithm of distance from the closest urban park and green area	Linear m
l_d_pan	Logarithm of distance from the closest scenic itineraries	Linear m
s_past	Area occupied by pastures	Percent over total municipal area
s_bush	Area occupied by bushes	Percent over total municipal area
s_sparse	Area occupied by sparse/scattered vegetation	Percent over total municipal area
s_urban	Area occupied by urban green areas	Percent over total municipal area
s_conif	Area occupied by coniferous forests	Percent over total municipal area
s_broadl	Area occupied by broadleaves forests	Percent over total municipal area
s_mixed	Area occupied by mixed forests	Percent over total municipal area
s_moorl	Area occupied by moorlands	Percent over total municipal area
s_mead	Area occupied by meadows	Percent over total municipal area

Statistics of the variables used in the computation of the BTF

Variable	Mean	Standard Deviation
Invididual mWTP in Adamello RP		
mWTP stab_20	2.71	14.66
mWTP stab_35	2.28	20.38
mWTP stab_45	7.64	30.78
mWTP con_200	7.62	21.31
mWTP con_250	9.15	25.43
mWTP con_300	15.04	37.82
mWTP faun_5	1.05	4.35
mWTP faun_7	2.11	5.23
mWTP faun_10	2.92	6.42
mWTP flor_2	1.45	5.68
mWTP flor_4	1.62	7.47
mWTP flor_6	4.55	16.72
mWTP sec_453	-0.86	4.27
mWTP sec_455	0.72	3.36
Invididual mWTP in Ticino RP		
mWTP rco_5	8.33	38.23
mWTP rco_10	13.48	88.21
mWTP rco_20	24.82	141.90
mWTP mWTP atq_3	-0.56	10.57
mWTP mWTP atq_4	-0.38	30.82
mWTP mar_400	0.84	7.60
mWTP mar_450	2.02	11.56
mWTP bved_6	1.33	21.49
mWTP bved_8	-2.08	24.83
mWTP bved_12	2.84	40.09
mWTP itin_65	-1.56	11.82
mWTP itin_67	-0.05	2.62
Exogenous variables		
edu	3.54	1.10
reddito	23.96	16.86
pop_tot	212649.32	439973.25
l_p_tot	10.24	1.99
med_fam	4.26	75.38
num_abit	106527.66	223432.06

l_n_abit	9.46	2.04
area	8515643.12	17537466.64
l_area	13.94	2.00
t_analf	0.63	1.34
t_an_nt	6.35	1.29
t_elem	19.74	3.98
t_medie	29.85	4.47
t_super	30.86	3.44
t_terz	0.49	1.20
t_univ	12.08	5.83
u_sec_19	41.06	24.95
d_sec_19	37.44	23.68
no_p_m	4.87	19.70
no_p_f	8.26	88.77
oc_agri	2.37	2.76
oc_ind	33.93	11.11
oc_com	18.89	2.70
oc_fin	17.58	6.77
oc_alt	27.23	6.22
cp_occ	39.27	2.79
cp_cer	3.01	1.10
cp_pens	20.35	2.93
cp_stud	5.08	0.97
cp_cas	7.03	1.70
cp_alt	3.02	1.18
cpm_occ	22.24	1.61
densita	2215.42	2241.69
d_strad	34012.67	33378.01
l_strad	9.34	2.73
l_d_reg	3.59	3.29
l_d_giar	4.10	3.33
l_d_pan	9.40	2.23
s_pasc	2.69	7.29
s_arb	1.04	3.06
s_rada	0.81	3.41
s_urban	0.09	0.92
s_conif	3.82	10.48
s_latif	16.12	22.92
s_misti	5.28	11.98
s_brugh	0.27	1.51
s_stabili	1.67	5.46
sop50	0.32	0.47
sot50	0.68	0.47

Choice task example for Ticino RP

Attributes	**Option A**	**Option B**	**Option C**

CO_2 emission reductions (%)	-10%	-10%	-5%
Water quality	4 species	4 species	3 species
Water meadow conservation (ha)	450 hectares	400 hectares	320 hectares
Scenic views with screened detractors (n.)	8 sites	0 sites	6 sites
Thematic trails (n.)	65 trails	67 trails	62 trails
Annual Tax (for 5 years)	15 Euro	5 Euro	10 Euro

Choice task example for Adamello RP

Attributes	Option A	Option B	Option C
Safe road network (km)	10 km	20 km	35 km
Meadow flora conservation (ha)	200 hectares	250 hectares	0 hectares
Fauna sighting sites (n.)	5 sites	5 sites	2 sites
Floristic trails (n.)	4 trails	6 trails	2 trails
Dry-stone wall restoration (ha)	455 hectares	453 hectares	453 hectares
Annual Tax (for 5 years)	2 Euro	2 Euro	5 Euro

Online survey (example)